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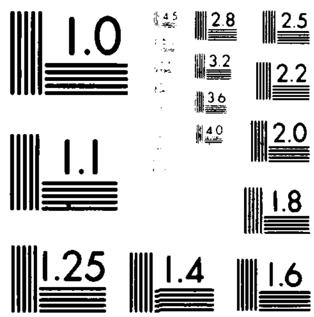


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# Products From Two Computer Programs Which Process Digital Bathymetric Data

by

Barry E. Herchenroder

COASTAL ENGINEERING TECHNICAL AID NO. 81-13

OCTOBER 1981



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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A description is given of products from two computer programs which process digital bathymetric data. One program generates regularly spaced bathymetric data from irregularly spaced data. The other uses regularly spaced data to determine and draw contours. A large set of irregularly spaced bathymetric data available on magnetic tape for U.S. coastal regions is also described. Examples of output from each program are displayed for two coastal areas.

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## PREFACE

This report describes products from two computer programs, and a set of digital bathymetric data for U.S. coastal regions. The programs and data are useful for generating regularly spaced bathymetric data and determining and drawing contours. The work was carried out under the waves and coastal flooding research program of the U.S. Army Coastal Engineering Research Center (CERC).

The present report was prepared by Dr. Barry E. Herchenroder, under the general supervision of Dr. C.L. Vincent, Chief, Coastal Oceanography Branch, Research Division.

Comments on this publication are invited.

Approved for publication in accordance with Public Law 166, 79th Congress, approved 31 July 1945, as supplemented by Public Law 172, 88th Congress, approved 7 November 1963.

For Billy B. Bost, LTC, CE
TED E. BISHOP
Colonel, Corps of Engineers
Commander and Director

A

CONTENTS



FIGURES

CONVERSION FACTORS, U.S. CUSTOMARY TO METRIC (SI) UNITS OF MEASUREMENT

U.S. customary units of measurement used in this report can be converted to metric (SI) units as follows:

| Multiply | by | To obtain |
|---|---|---|
| inches | 25.4 | millimeters |
| | 2.54 | centimeters |
| square inches | 6.452 | square centimeters |
| cubic inches | 16.39 | cubic centimeters |
| feet | 30.48 | centimeters |
| | 0.3048 | meters |
| square feet | 0.0929 | square meters |
| cubic feet | 0.0283 | cubic meters |
| yards | 0.9144 | meters |
| square yards | 0.836 | square meters |
| cubic yards | 0.7646 | cubic meters |
| miles | 1.6093 | kilometers |
| square miles | 259.0 | hectares |
| knots | 1.852 | kilometers per hour |
| acres | 0.4047 | hectares |
| foot-pounds | 1.3558 | newton meters |
| millibars | $1.0197 \times 10^{-3}$ | kilograms per square centimeter |
| ounces | 28.35 | grams |
| pounds | 453.6 | grams |
| | 0.4536 | kilograms |
| ton, long | 1.0160 | metric tons |
| ton, short | 0.9072 | metric tons |
| degrees (angle) | 0.01745 | radians |
| Fahrenheit degrees | 5/9 | Celsius degrees or Kelvins[1] |

[1]To obtain Celsius (C) temperature readings from Fahrenheit (F) readings, use formula: $C = (5/9)(F - 32)$.

To obtain Kelvin (K) readings, use formula: $K = (5/9)(F - 32) + 273.15$.

# PRODUCTS FROM TWO COMPUTER PROGRAMS WHICH PROCESS DIGITAL BATHYMETRIC DATA

*by*
*Barry E. Herchenroder*

## I. INTRODUCTION

Regularly spaced bathymetric data are needed by the U.S. Army, Corps of Engineers for input to various numerical models which describe coastal phenomena such as storm surge and wave refraction. Bathymetric contours produced from such data are also sometimes needed to help locate important bathymetric features or changes in a project area. To generate regularly spaced bathymetric data, an adequate set of raw irregularly spaced data must be available and a method to interpolate-extrapolate this data to regularly spaced locations is required. This report describes a large set of bathymetric data available on magnetic tape and products from a computer program which generates regularly spaced data from the raw data; products from a program which generates contours from the regularly spaced data are also described.

One source of raw bathymetric data in an area affected by a coastal project may be survey data taken as part of the project. If there are no such data or if the project survey data must be supplemented, a major additional data source is the National Ocean Survey (NOS) digital hydrographic data set available from the National Geophysical and Solar-Terrestrial Data Center (NGSDC) of the National Oceanic and Atmospheric Administration (NOAA). Data from both data sources normally have an irregular spacing.

Interpolating-extrapolating irregularly spaced data to regularly spaced locations is onerous when done by hand. Drawing depth or bed elevation contours by hand is also time consuming and tedious. To simplify these tasks at the Coastal Engineering Research Center (CERC), two computer programs, ZGRID1 (program No. 72ØX6RICGØ) and CONTOR (program No. 72ØX6R19XØ), have been developed or modified. ZGRID1 interpolates or extrapolates and CONTOR determines and draws contours. The two programs are available with documentation from the Engineering Computer Programs Library at U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Both ZGRID1 and CONTOR require large, fast computers, e.g., CDC 66ØØ, CDC CYBER176, CRAY-1, IBM 3Ø33, and use standard CALCOMP plotting commands.

## II. NOS DIGITAL DATA

A few years ago, NOS began digitizing U.S. coastal hydrographic data from about 3,200 survey sheets. Most of the resulting digital data have been archived with the NGSDC; they are available on magnetic tape for a fee by writing or phoning National Geophysical and Solar-Terrestrial Data Center, Code D621, EDS/NOAA, Boulder, Colorado 80302, phone (303) 499-1000, extension 6338 (FTS 373-6338). A detailed description of the available digital data, as well as pricing information, is given in National Geophysical and Solar-Terrestrial Data Center (1976, 1979a, 1979b, 1980) and in Lawrence (1977). The digital data are irregularly spaced in latitude and longitude and consist of about 97 percent depth soundings and 3 percent bottom characteristics (e.g., clay, mud, soft, etc.) and dangers to navigation (e.g., wrecks, pilings, etc.) The 1° square areas along the continental United States and Alaskan coasts for which

digital data were available as of January 1981 are indicated in Figures 1 and 2. Data from the squares in Figures 1 and 2 were digitized from surveys conducted between 1930 and 1965.

## III. PROGRAM ZGRID1

ZGRID1 is a modification of the program supplied by NGSDC to perform two-dimensional interpolation-extrapolation. Irregularly spaced bathymetry data from the NOS digital tapes or from independently obtained surveys are read by ZGRID1. ZGRID1 then determines the coordinates of each sounding on a map projection preselected by the user and interpolates-extrapolates this data to regularly spaced locations on the projection.

As an option of ZGRID1, a plot of the irregularly spaced soundings can be made. Figures 3 and 4 are examples of such plots. Figure 3 shows the soundings offshore of Great Egg Harbor Inlet, New Jersey, on a 0.03° (1.8 minute) latitude-longitude square. Soundings were obtained from the NGSDC tape covering the 1° latitude-longitude square 39° to 40° N. latitude, 74° to 75° W. longitude. Figure 4 consists of bed elevations near CERC's Field Research Facility (FRF) at Duck, North Carolina. The FRF bed elevations were derived from a survey made by CERC in September 1978.

The estimated bed elevation or sounding value at each regularly spaced location can be written on a magnetic disk or tape for subsequent use. At the user's discretion, the regularly spaced values can be printed on a lineprinter or plotted. Figure 5 is a plot of the estimated regularly spaced depth values for the same region covered by Figure 3. For this example, there are 30 regularly spaced (on the map projection) points in both the x and y directions for a total of 900 regularly spaced points in the whole region.

## IV. PROGRAM CONTOR

CONTOR determines and draws contours of any variable from a two-dimensional array of variable values. These values are assumed to be located at regularly spaced grid points. CONTOR was developed at the Carnegie-Mellon University, Pittsburgh, Pennsylvania, by Robinson and Scarton (1972). When used to contour bed elevation or water depth fields, CONTOR is usually run in conjunction with ZGRID1. ZGRID1 produces the depth or bed elevation values at regularly spaced locations needed by CONTOR. The contours to be plotted are specified by the user.

Figures 6 and 7 are examples of contour plots done by CONTOR. Figure 6 corresponds to the region off Great Egg Harbor Inlet covered by Figures 3 and 5. Figure 7 corresponds to the FRF region covered by Figure 4. Figure 6 was produced from the ZGRID1 computed values in Figure 5. Figure 7 was produced from ZGRID1 computed regularly spaced values (not shown) located 82.02 feet (25 meters) apart in both x and y directions.

## V. LIMITATIONS

Limited experience indicates that the data on the NGSDC tapes contain a few gross errors in most 0.25° by 0.25° squares. One satisfactory way to detect these errors is through the use of contour plots. Gross data errors are easily located on these plots since they appear as small "bull's-eyes."

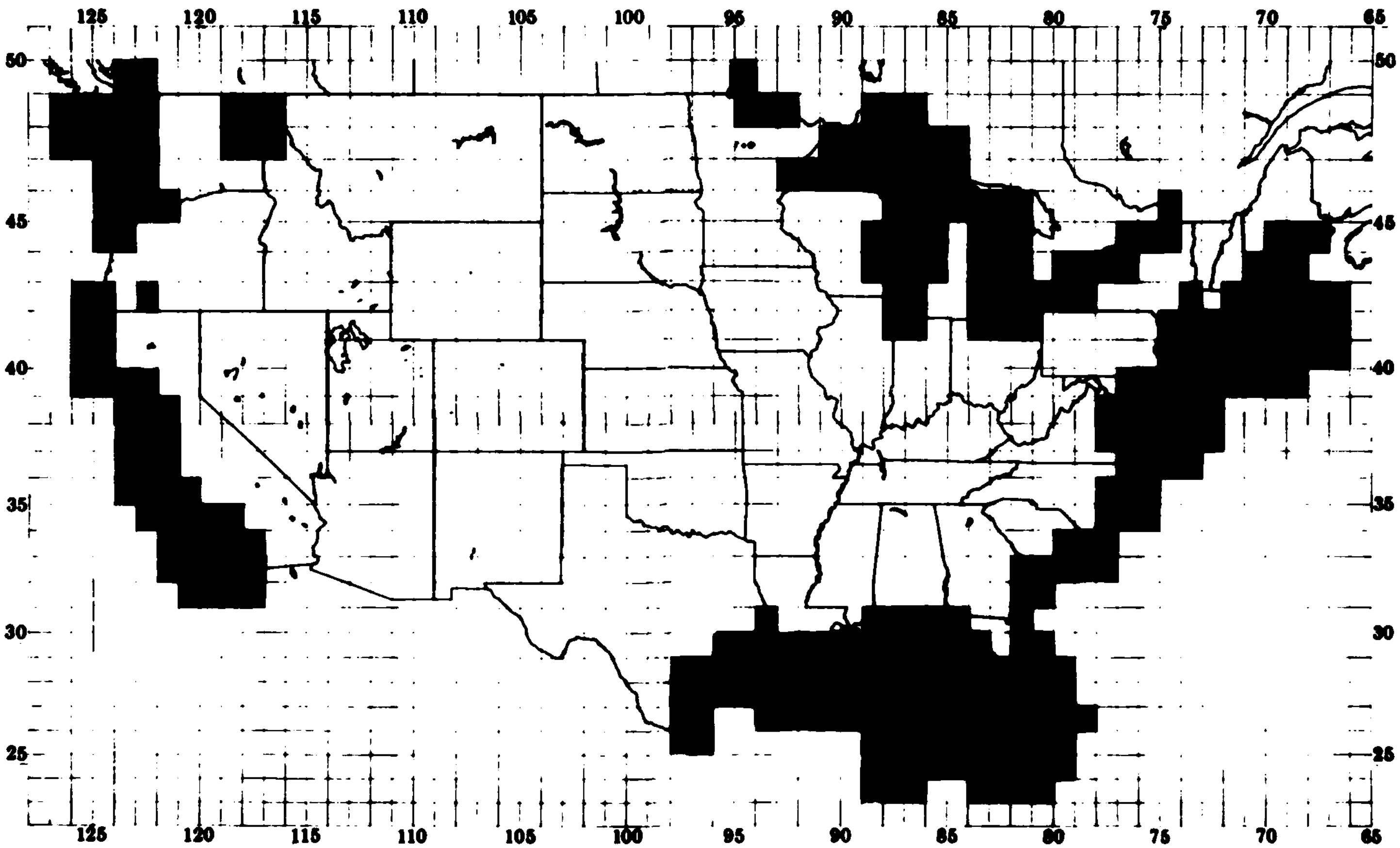


Figure 1. Index (1° square areas) to hydrographic data (except those of the Alaskan coast), 1930 to 1965 only, available on tape from NGSDC (National Geophysical and Solar-Terrestrial Data Center, 1980).

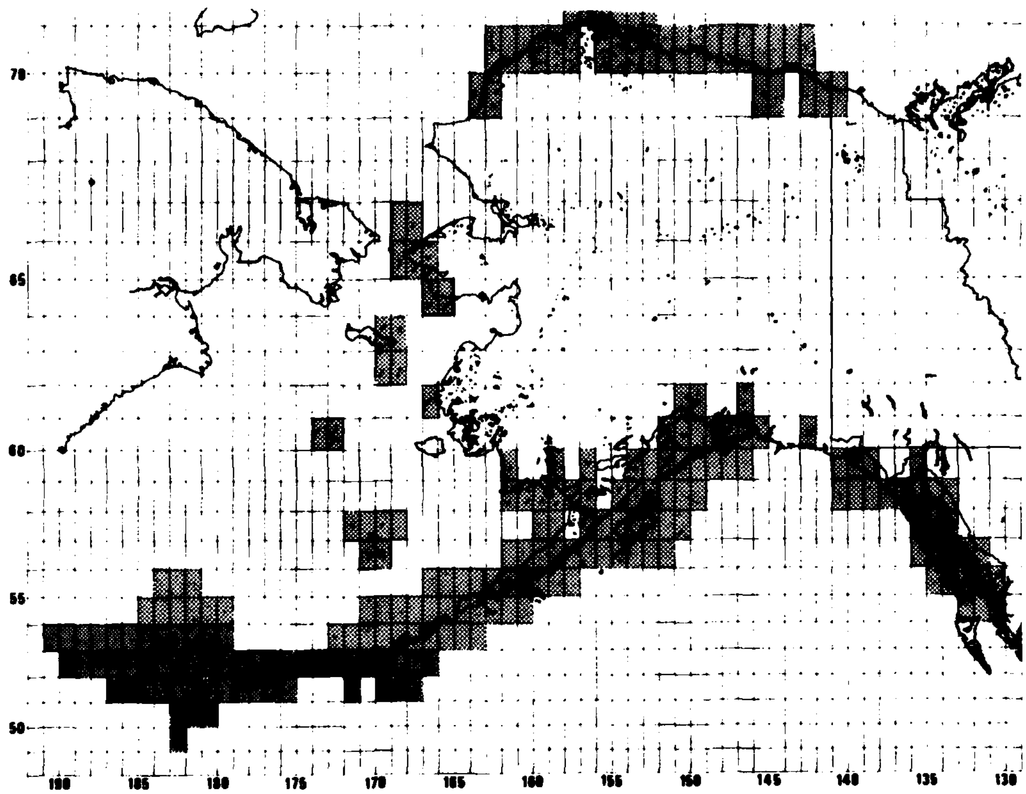


Figure 2. Index (1° square areas) to hydrographic data off the Alaskan coast, 1930 to 1965 only, available on tape from NGSDC (National Geophysical and Solar-Terrestrial Data Center, 1980).

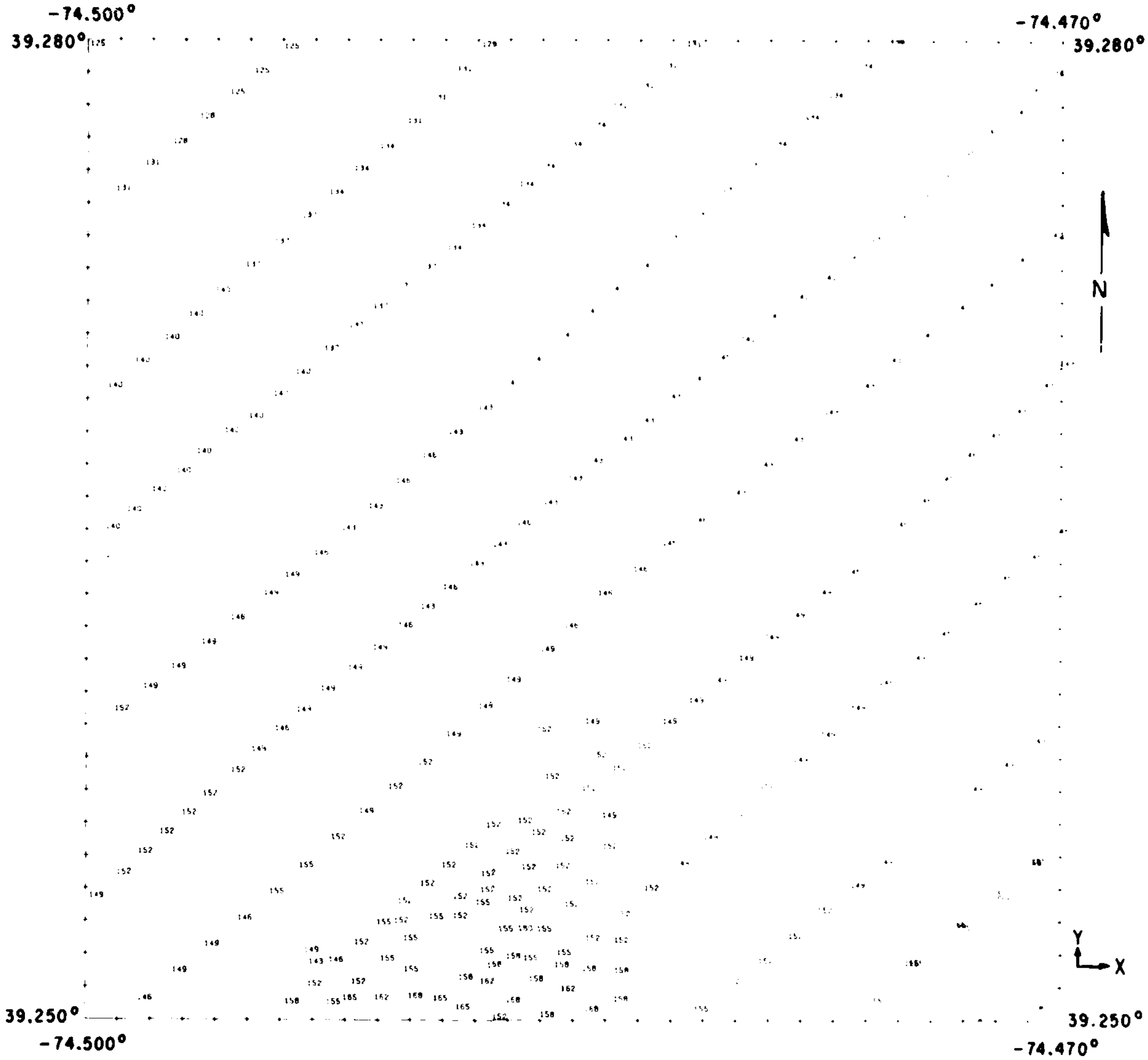


Figure 3. ZGRID1-produced soundings offshore of Great Egg Harbor Inlet, New Jersey, in a 0.03° square area. Axis annotations are N. latitudes (positive numbers) and W. longitudes (negative numbers). Depths are in tenths of meters referenced to MLW.

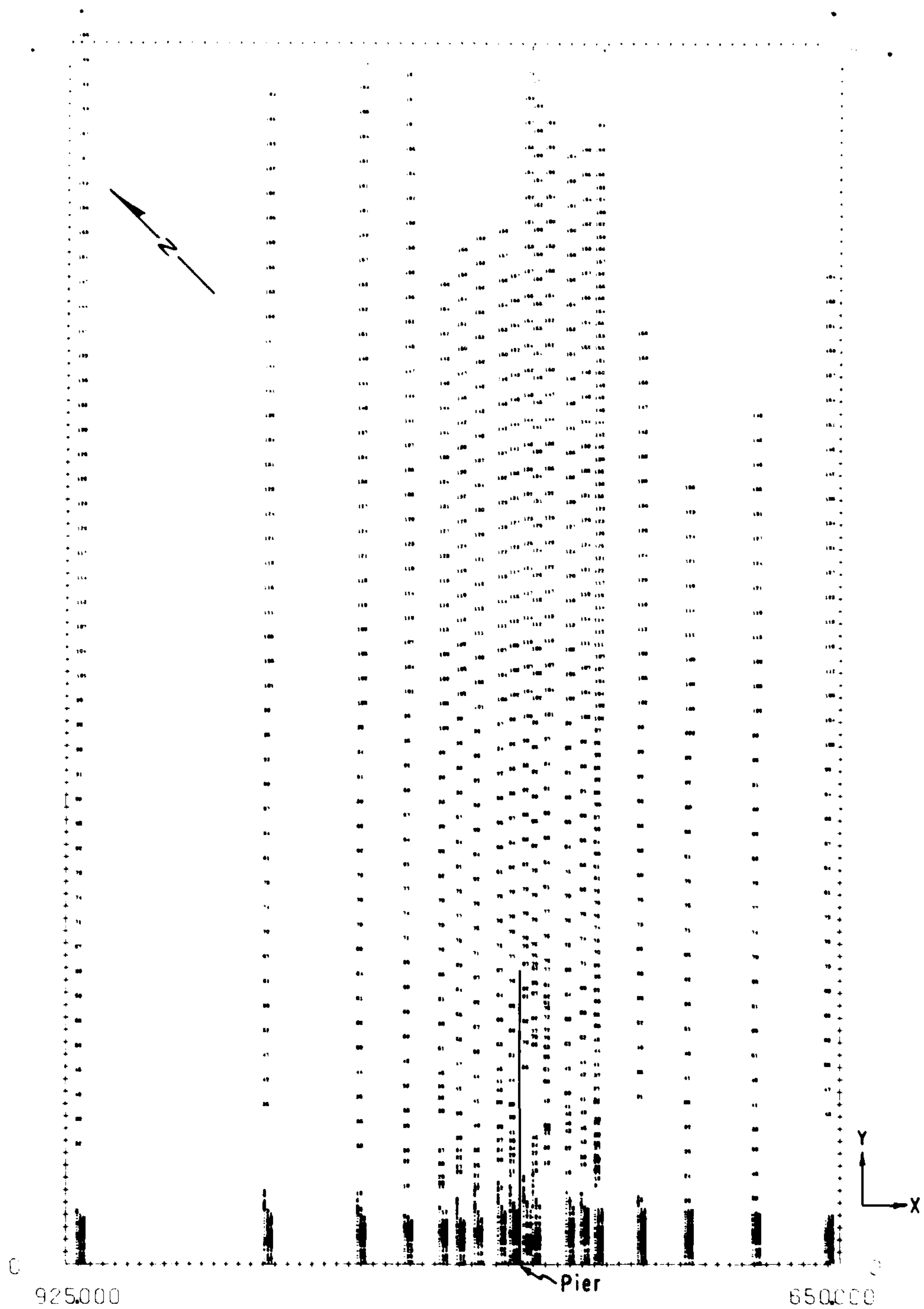


**Figure 4.** ZGRID1-produced bed elevations near CERC's FRF at Duck, North Carolina. The CERC pier has been drawn in by hand. Axis annotations are in meters. Bed elevations are in tenths of meters reference to the 1929 National Geodetic Vertical Datum. Negative elevations are above the datum.

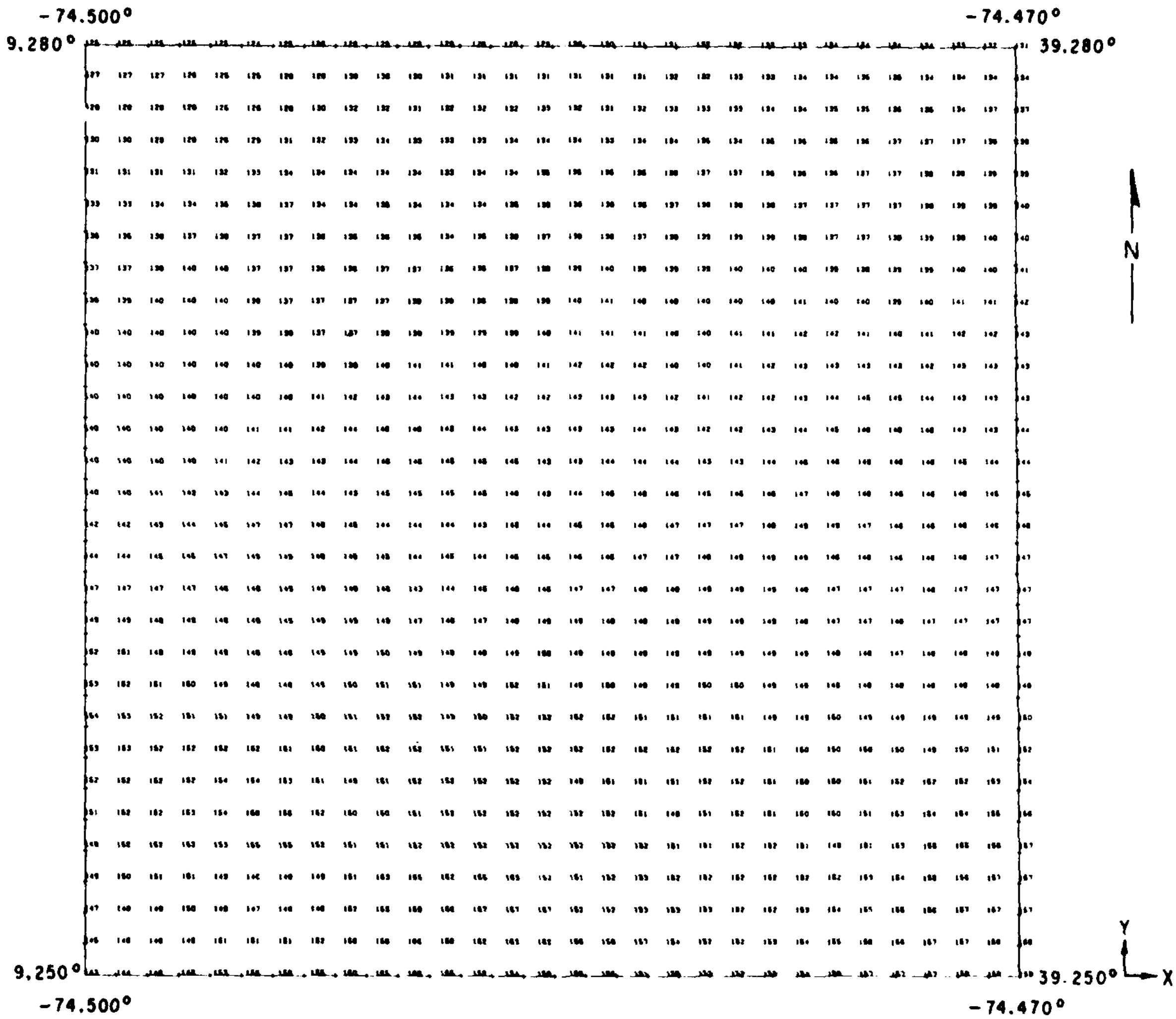


Figure 5. ZGRID1-produced regularly spaced depth values for the same area off of Great Egg Harbor Inlet, New Jersey, covered by Figure 3. Depths are in tenths of meters referenced to MLW.

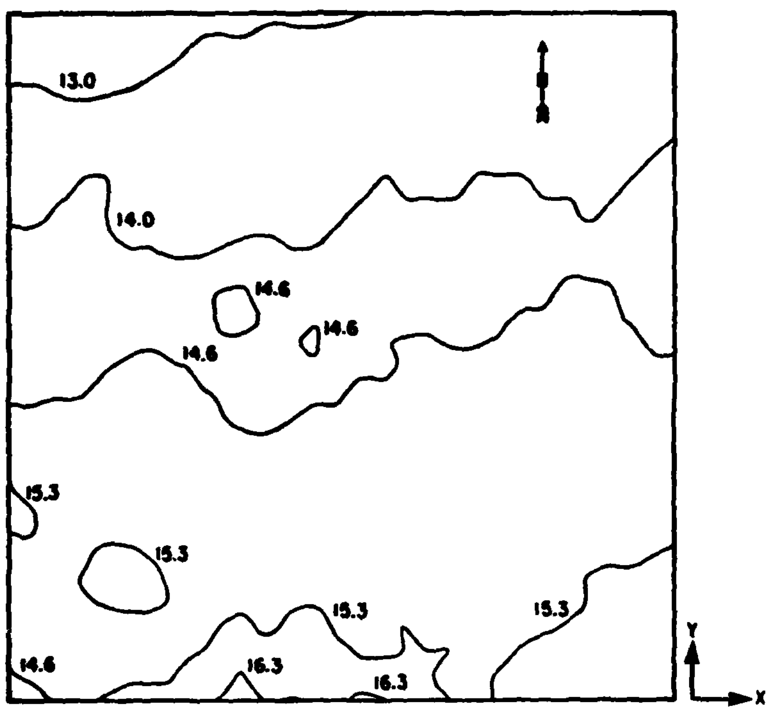


Figure 6. CONTOR-produced depth contours for the same area off of Great Harbor Inlet, New Jersey, covered by Figures 3 and 5. Contour values are in meters.

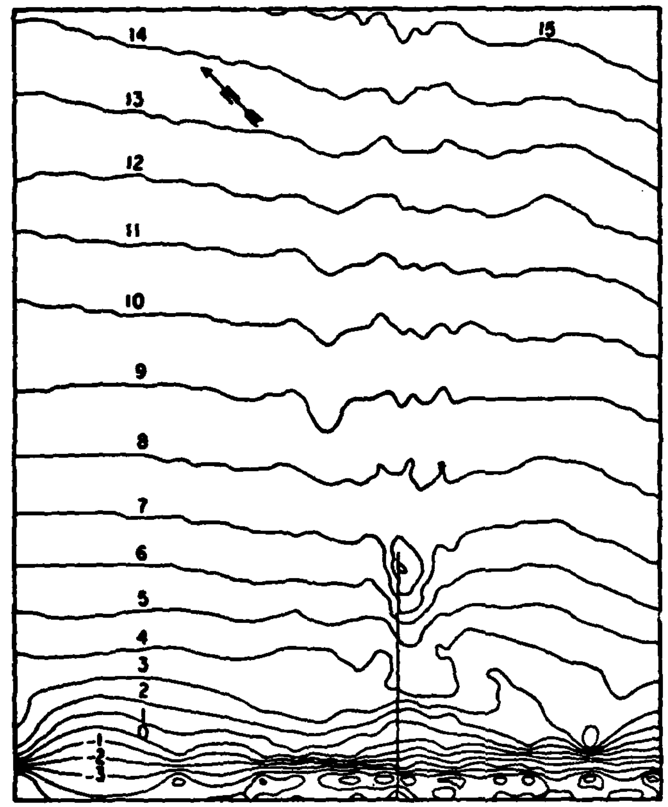


Figure 7. CONTOR-produced depth contours for the same region near CERC's FRF covered by Figure 4. Contour values are in meters.

1. ZGRID1.

ZGRID1 sometimes gives poor results near a land-water boundary or an outer computational boundary where there are too few irregularly spaced raw data points. Where there is a significant topographic trend, ZGRID1 can also give misleading results if the number of raw data points is too small.

2. CONTOR.

When a bathymetric feature has a size comparable to the grid spacing, contours which go near or through the feature may cross or have unrealistic loops or wiggles. To minimize this contour "noise," the regularly spaced depth or bed elevations produced by ZGRID1 may have to be smoothed.

## VI. SUMMARY

This report gives general descriptions of products from two computer programs (ZGRID1 and CONTOR) which process digital bathymetric data. ZGRID1 generates regularly spaced bathymetric data from irregularly spaced data, and CONTOR uses regularly spaced data to determine and draw contours. A large set of bathymetric data available on magnetic tape for U.S. coastal regions is also described. Examples of program output are presented for two areas, one near Great Egg Harbor Inlet and the other near CERC's FRF.

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